ABSTRACT OF THE DISCLOSURE

[0104] In accordance with the present invention, there are provided toughening agents which are useful for improving the performance properties of epoxy-based adhesive formulations. For example, epoxidized polybutylacrylates have been found to be useful toughening agents of component level underfill adhesive compositions. Invention materials are generally liquid rubbers which provide improved fracture toughness while maintaining satisfactory capillary flow properties. Invention materials can be synthesized in neat (solventless) reactions from readily available low-cost raw materials and isolated in high yields. They have a branched telechelic structure with terminal epoxide functional groups. The polyacrylate is typically obtained as a mixture of epoxidized polymer, chain extended poly-oligomer and unreacted monomer. Invention materials are compatible with common epoxy formulations and may be used without purification. At low levels of incorporation, they provide adhesives that meet the minimum fracture toughness ($G_q > 2.0$ lb/in) and capillary flow specifications (flow time < 180 seconds) for many commercial underfill applications. In accordance with a further embodiment of the present invention, there are provided adhesive compositions comprising invention compounds and methods for use thereof. In additional embodiments of the present invention, there are provided methods for the preparation of invention toughening agents, methods for adhesively attaching a device to a substrate, and assemblies comprising first article(s) adhered to second article(s).